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(54) Real time status monitoring

(57) In real time status monitoring involving inputting randomly varying data (7) relating to a plurality of objects, processing a plurality of functions having some of the data (7) as variables and monitoring an overall status including the objects on a real time basis, a table (10) indicating the presence or absence of data change in the objects and the presence or absence of variables related to the data change in the functions is used and only those functions which include the variables related to the data change are processed.

Application may be to financial market quotes or traffic control.

F I G. 1

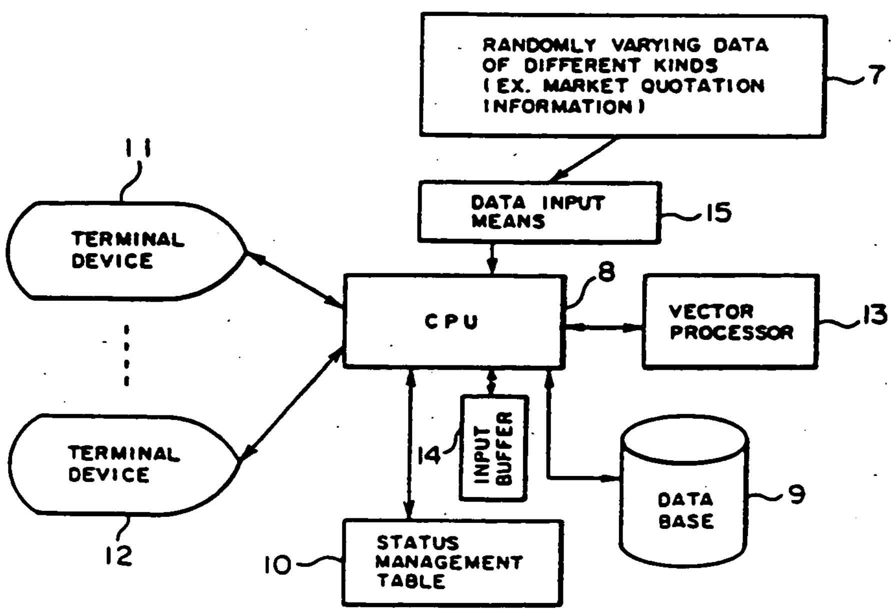

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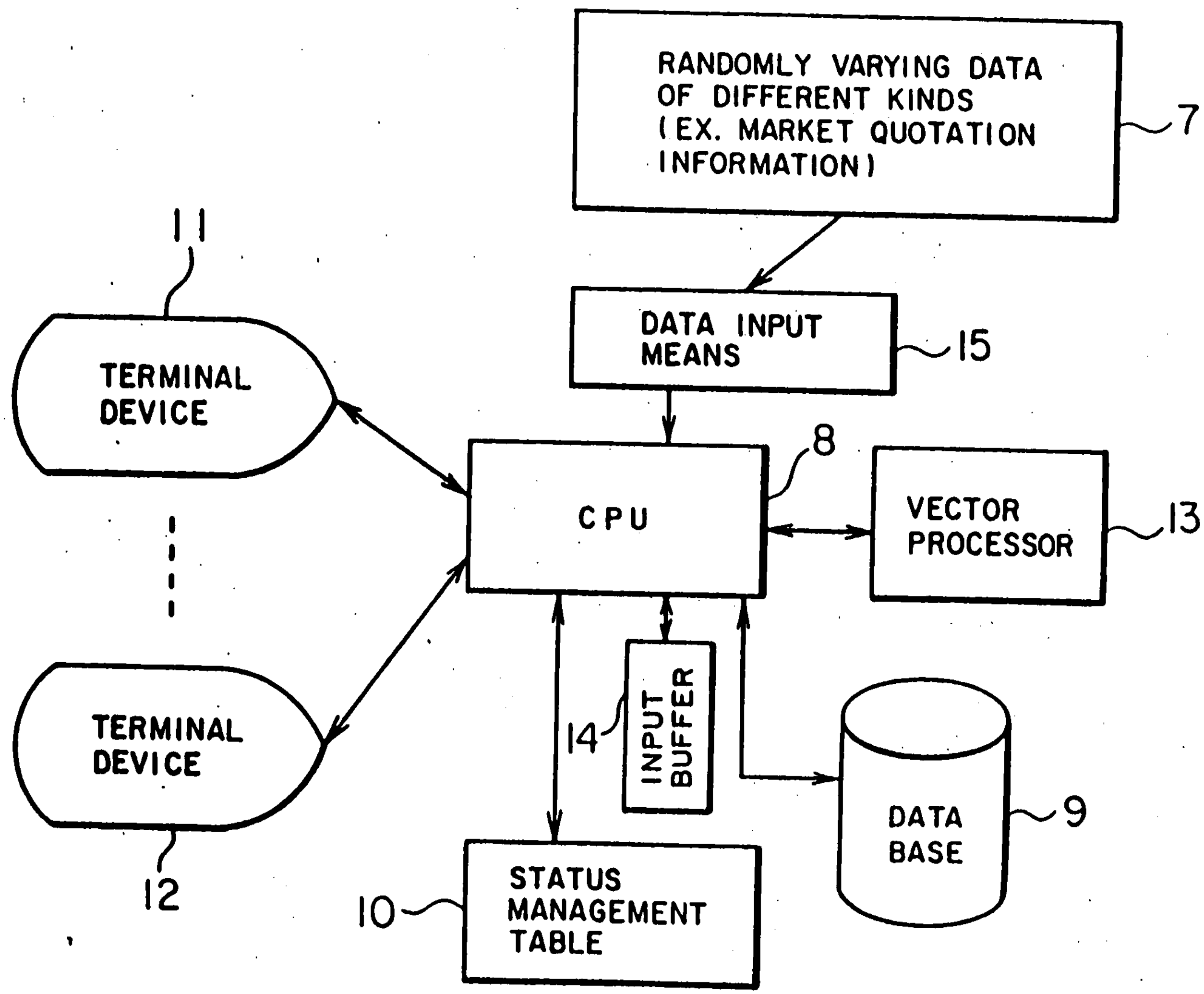
FIG. 1



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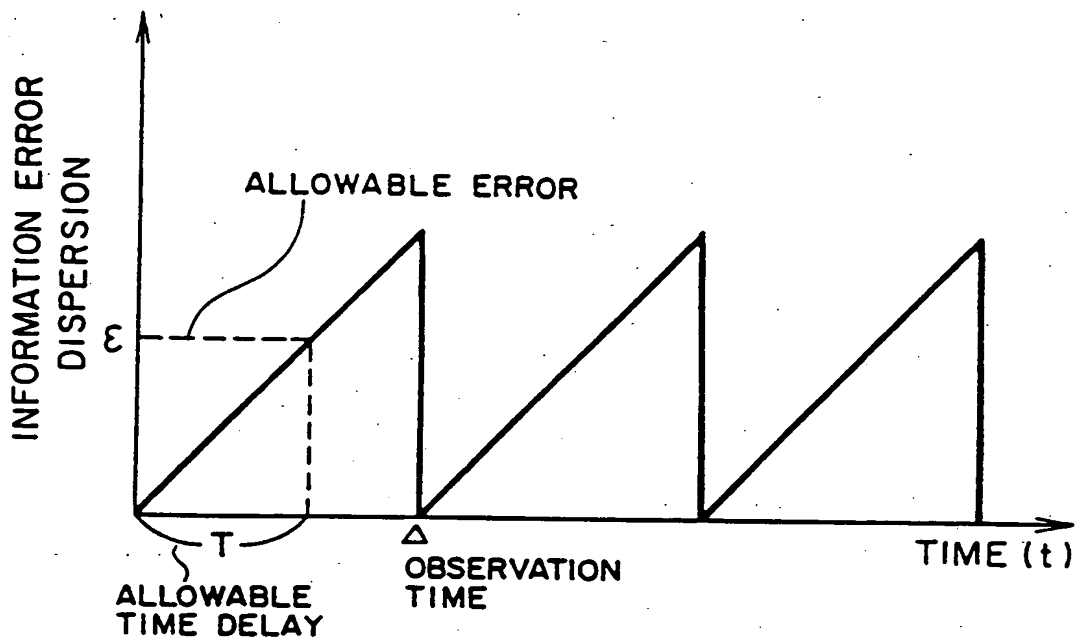
F I G. 3A



F I G. 3B

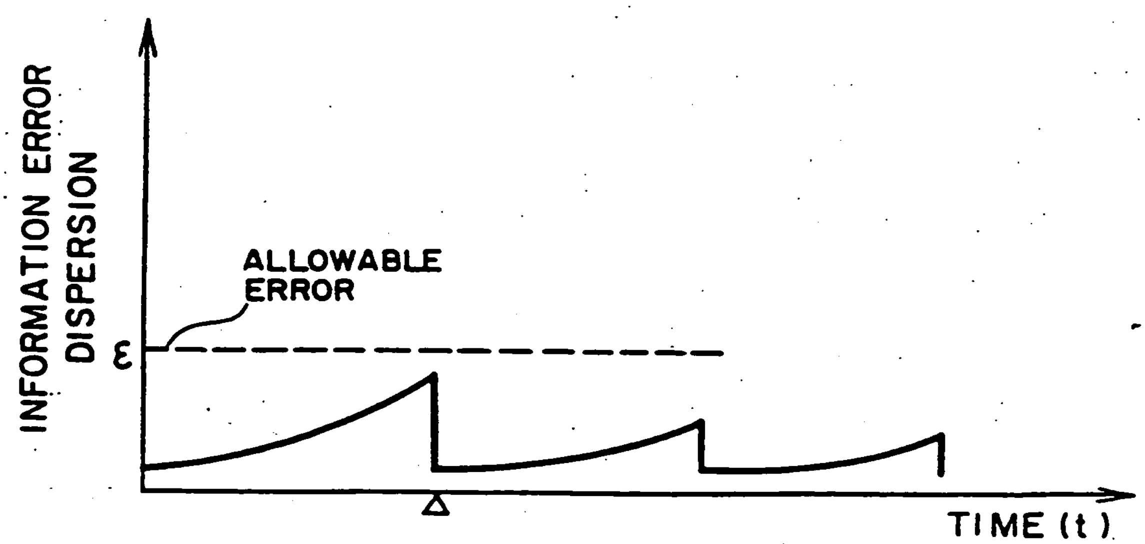


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FIG. 5

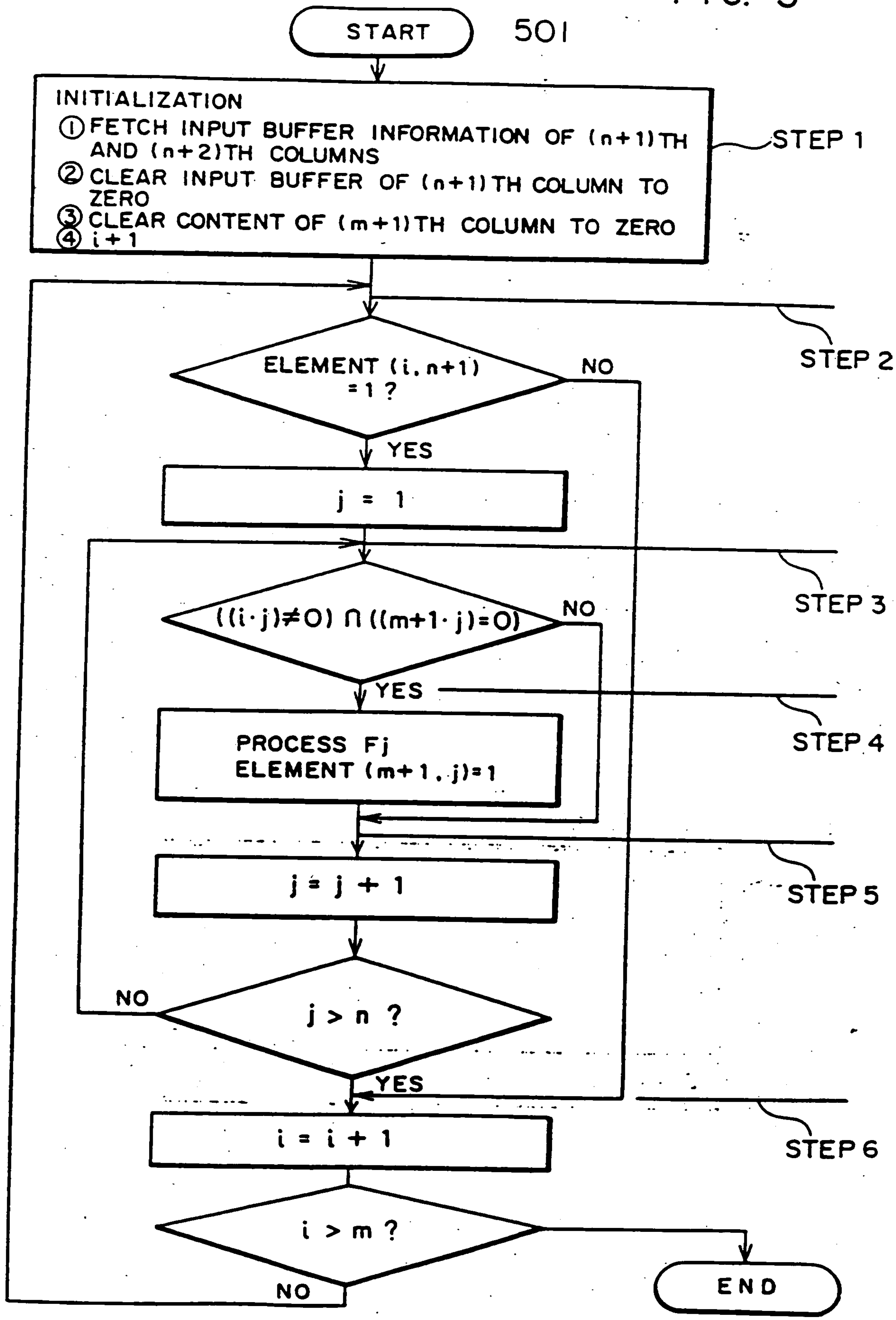

FIG. 7

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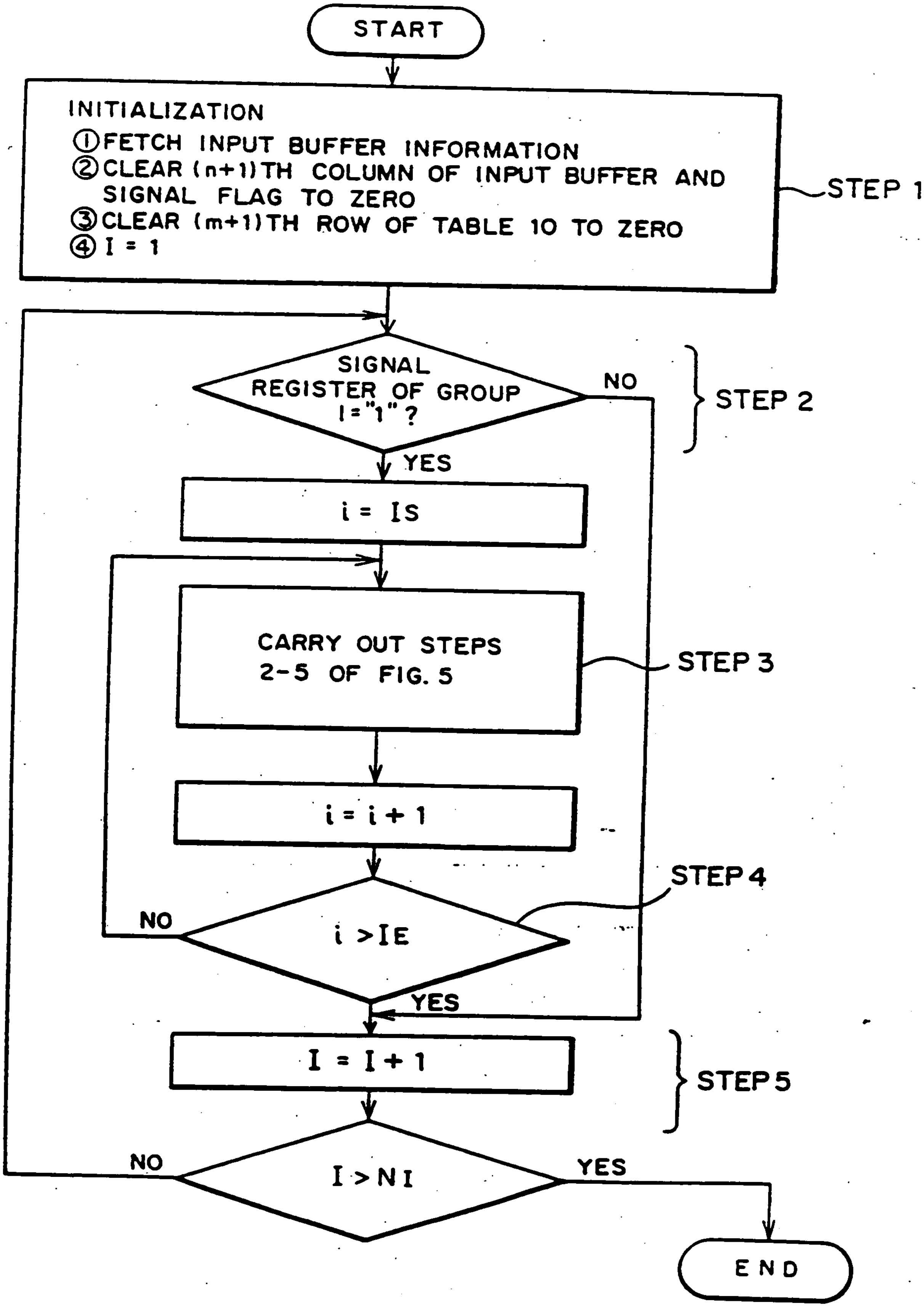


FIG. 9A

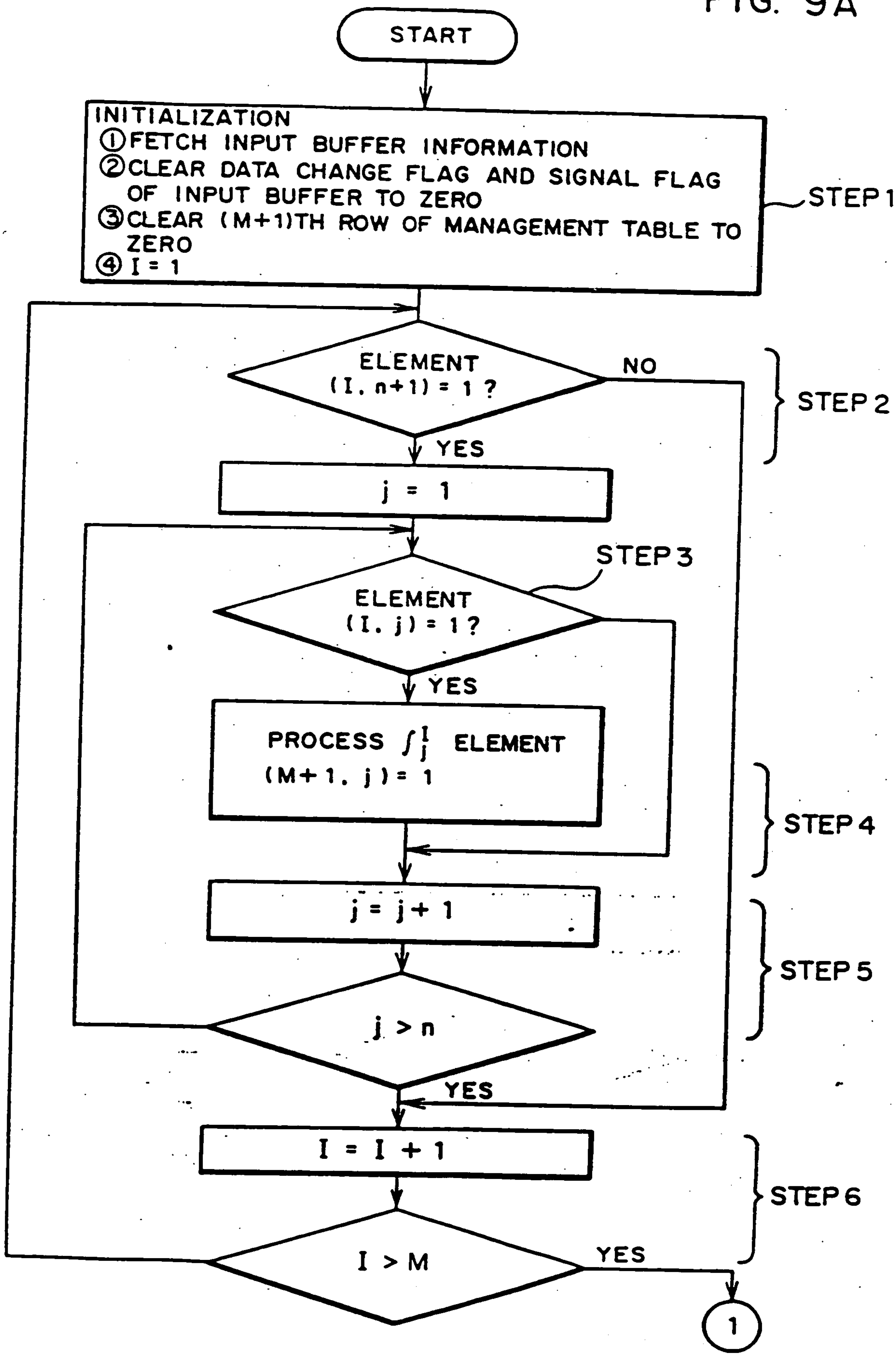

START
INITIALIZATION
①FETCH INPUT BUFFER INFORMATION
②CLEAR DATA CHANGE FLAG AND SIGNAL FLAG OF INPUT BUFFER TO ZERO
③CLEAR (M+1)TH ROW OF MANAGEMENT TABLE TO ZERO
④I = 1
STEP 1
ELEMENT (I, n+1) = 1 ?
NO
YES
STEP 2
j = 1
STEP 3
ELEMENT (I, j) = 1 ?
YES
PROCESS f_j^I ELEMENT
(M+1, j) = 1
STEP 4
j = j + 1
STEP 5
j > n
YES
I = I + 1
STEP 6
I > M
YES
1

FIG. 10

10

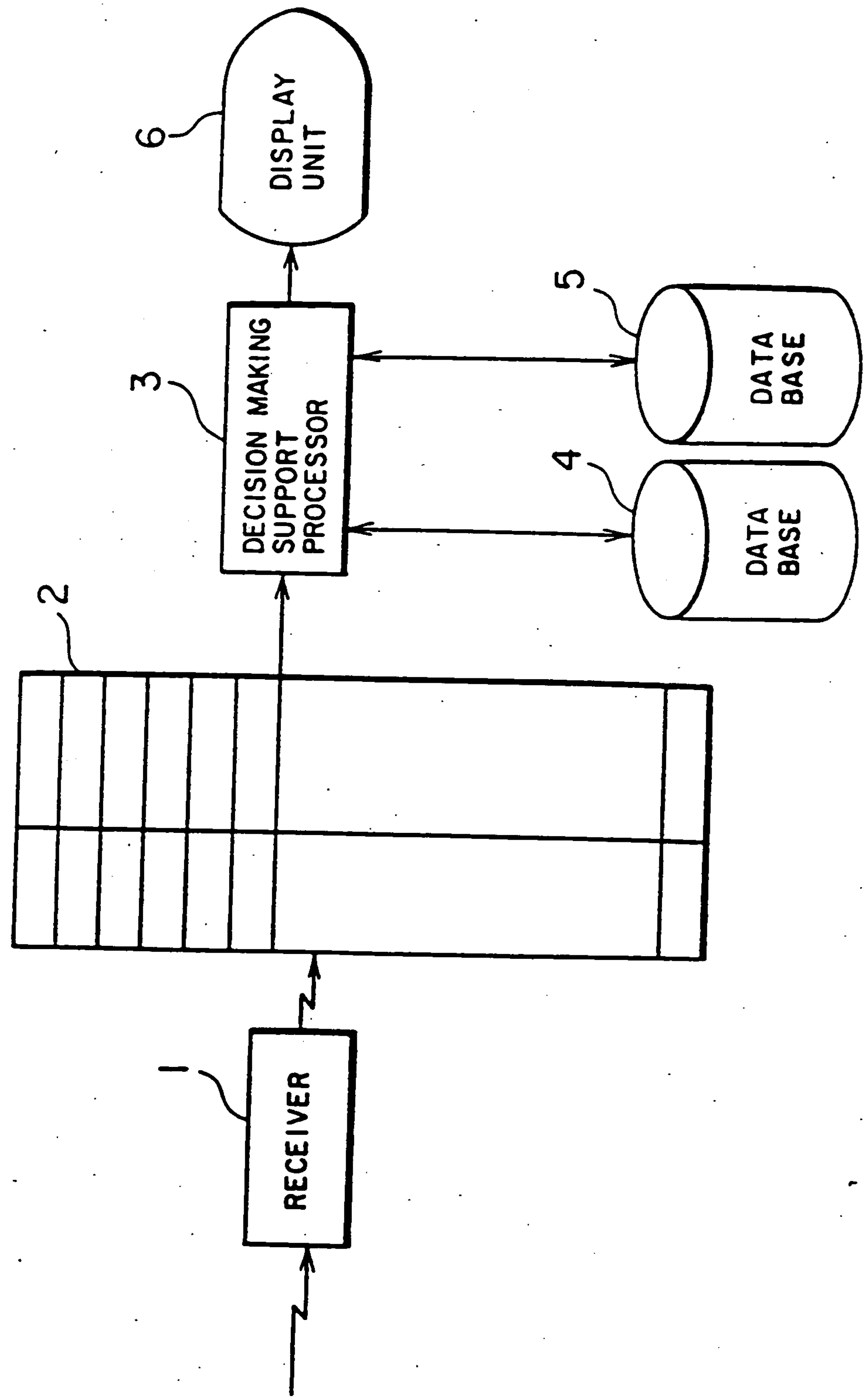
GROUP	F1	F2	---	Fn	SIGNAL FLAG
1	$(f_1^I)^R$				0
2	0				1
3	0				0
		$(f_2^I)^R$			
M					
	0	1			
		$(F2)^P$			
		F2			

DECISION MAKING SUPPORT INFORMATION

INFORMATION COMPRISING ONLY PAST TIME SERIAL DATA OF (Fj) P

DECISION MAKING SUPPORT INFORMATION UPDAING FLAG

FIG. 12



6
DISPLAY UNIT
3
DECISION MAKING SUPPORT PROCESSOR
5
DATA BASE
4
DATA BASE
2
1
RECEIVER

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"REAL TIME STATUS MONITORING METHOD AND APPARATUS THEREFOR"

The present invention relates to a real time status monitoring method and an apparatus therefor, and more particularly to a data processing method in a real time status monitoring system which determines a status and makes a decision on a real time basis based on a huge amount of data information which randomly varies with respect to an object, and a system therefor.

Specifically, the present invention is applicable to a trading support system based on market quotation in financial and security fields, a support system for measurement, monitor, control and decision making, comprising a number of sensors, and a support system for status determination and decision making for aviation control or traffic control.

While the present invention is applicable to various fields, it will be explained as a trading support system in the financial and security field.

An outline of the support system for making a decision in accordance with status such as the trading support system in the financial and security field is shown in Fig. 12, in which market quotation information which contains a huge number of varying stock and credit prices is r ceived by a receiver 1, and lat st data to be monitored is supplied to a real time status sensing table

No. 8 (1983), "A track correlation algorithm for multi-sensor integration" IEEE/AIAA 5th DIGITAL AVIONICS SYSTEMS CONFERENCE, Oct. 31-Nov. 3, 1983, PP. 10.3.1-10.3.8). In the known multi-target tracking processing, the status changes of all targets to be monitored are always due to the movement by a physical law. Thus, the status of the target at any time can be predicted by a Kalman filter within a certain range of error even if the observation and the status inference are done at the constant time interval. Accordingly, it is an effective processing method in an aviation control system and a command and role system.

The above method may be applied to the decision making support processing of the trading support system shown in Fig. 12. It is assumed that the market quotation information (stocks and credits whose data are varying and prices thereof) has been stored in the real time status sensing table. Decision making support information processing groups {Fi} are processed at a constant time interval as shown in Fig. 2. All information processing groups {Fi} are processed in accordance with the content of the real time status sensing table 2 at a time Ti, and the results are supplied to the display unit. The same processing is performed to the content of the real time status sensing table at a time T_{i+1} (= Ti + ΔT) which is ΔT time later than the time Ti. The time ΔT must be larger than a sum f processing times for all inf rmation processing groups.

making support information. In the case of market quotation information such as stocks and credits, this time delay is a very significant factor to degrade the information because no prediction can be made for a future status as it is done for the tracking processing. As described in many references, if the price change in the market quotation occurs in an random walk manner, an error dispersion of the price is expressed by $\sigma^2 T$ which monotonously increases with the increase of the time delay T. On the other hand, in the case of tracking processing, the prediction error of the prediction processing is increased by the time delay T but the effect is much smaller than that in the status monitoring of the market quotation without the prediction processing. The information error transitions due to the time delay in the status monitoring of the market quotation and in the tracking processing are shown in Figs. 3A and 3B, respectively. Where the huge number of objects are to be monitored and the changes of data occurs randomly, it is necessary to realize a real time decision making supporting information processing method which can avoid the unnecessary processing described above, in order to reduce the updating process time interval ΔT.

The present invention realizes a system which receives data relating to a number of objects of different kinds, processes a plurality of functions having data of a portion of th objects as variables and m nitors an overall status including the objects on a real time basis.

data component, and a calculation result stored in a memory area is used for the past data component and the processing is performed only for the present data component. As a result, the data processing speed is improved and the advantage of the present invention is prominent.

In accordance with the present invention, high speed data processing with the same precision can be attained with a conventional data processing system having a relatively low processing speed, and the time delay between the data input and decision making can be reduced even in such a case.

The present invention will now be described in greater detail by way of examples with reference to the accompanying drawings, wherein:-

Fig. 1 shows a configuration of one embodiment of a real time status monitoring system of the present invention,

Fig. 2 illustrates a relationship between objects to be monitored and decision making support processing,

Fig. 3A illustrates information error transition of support information for decision making based on status, in status monitoring of market quotation,

Fig. 3B illustrates information error transition of support information for decision making based on status, in tracking processing,

Fig. 4 shows a format of a status management table,

Fig. 1 shows a system configuration of a real time status monitoring system of the present invention which is applied to a portfolio status monitoring system for calculating a current total price of the portfolio based on market quotation variation information of the stocks and credits and issuing warning when it is smaller than an expected current total price (guaranteed current total price).

A central processing unit 8 receives market quotation information informed from a field 7 such as a securities exchange, that is, randomly varying data relating to objects of different kinds, processes various functions (for example, calculation of profit and loss of the retained portfolio, and displays the result on terminal devices 11 and 12. A data base 9 contains time serial data of the market quotation and information associated with the portfolio. A status management table 10 is a main part of the present invention and detail thereof is shown in Fig. 4. In a vertical direction, firm names Mi (i = 1 $\sim$ m), a current total amount change flag, a current total amount and a guaranteed current total amount for checking the status of the portfolio are arranged. On the other hand, in a horizontal direction, portfolios Fi (i = 1 $\sim$ n), a price change flag (data change flag) and current prices (curr nt stock prices of firms) Pi (i = 1 $\sim$ m) are arranged. An element ωij in the matrix management table indicates the number of retained

(current price change flag) to "1". Then, it starts the processing shown in the flow chart of Fig. 5 at the time interval Δt (501).

Step 1: When the updating of the decision making support information (the current total amount and the guaranteed total amount in the (m+1)th and (m+2)th rows) is to be started, the following initialization is effected.

(i) Read the input buffer information for the (n+1)th column and the input buffer information for the (n+2)th column, from the input buffer 14 to the (n+1)th column and the (n+2)th column of the management table 10.

(ii) Clear the input buffer for the (n+1)th column to zero.

(iii) Clear the content of the (m+1)th row of the table 10 to zero.

(iv) Start the processing of the functions {Fi} starting from i = 1.

Step 2: Check the content of the element (i, n+1) relating to the price change flag. If it is "0", it means no change in the data of Mi and the decision making supporting process relating to Mi is not necessary. Proceeds to a step 6. If the content of the element (i, n+1) is "1", it means that the data of Mi has been changed and the processing Fj for the steps 3 et seq should be initiated. Start the processing starting from j = 1.

Step 3: Check the content of the element (i, j). If it is "0", it means that the proc ssing F_4 does not relate to the object Mi to be monitor d. Proceeds to a step 5.

terminal device as the warning message.

In this manner, the real time monitoring of the portfolio is attained.

Fig. 6 shows the contents of the status management table 10 used in other embodiment and the input buffer 14.

Of the huge number of objects to be monitored such as the variation of the market quotation of the stocks and credits, some objects have their data frequently changed and some other objects have their data not frequently changed. For those which have a low frequency of data change, it is desirable to make the number of times of checking the data change flag as small as possible. To this end, the data is efficiently grouped. In the embodiment shown in Fig. 6, the data change detection of the objects to be monitored is grouped.

As shown in Fig. 6, M signal registers each comprising a signal flag (ON = "1", OFF = "0"), a group top item number I_S and a group bottom item number I_E are added to each of the management table 10 and the input buffer 14, and measuring registers for the frequency for the respective objects to be monitored are added to the input buffer 14.

The objects Mi to be monitored are arranged in the descending order of the frequency of data change, and the objects to be monitored are grouped into groups each consisting of N_I objects (I = 1, ... M) starting from the top object. A signal for detecting the data change in

$$I_E = \sum_{K=1}^{I} N_K \text{ , and}$$

Q_I is a probability that the signal flag for the detection of the status change in the I-th group is "1", that is,

$$Q_I = 1 - \prod_{i=I_S}^{I_E} (i - Pi)$$

It should be smaller than K_1, and K_2 should be minimum. The value of K_2 depends on the number of signal flags and the grouping method if the probability of the status change is larger when the item number is smaller. Accordingly, it is necessary to monitor the occurrence of the status change of the objects M_i to be monitored and optimize the grouping based on it. If the grouping is not proper, the number of times of check may rather increases.

The processing method of the present embodiment which uses the table 10, the input buffer 14 and the signal registers is explained for the following three steps.

(1) Data change input of the object to be monitored

Since the data change in the object to be monitored is informed from time to time, the flag of the input buffer 14 corresponding to the informed firm Mi is set to "1", the status amount is stored, the data change frequency register is counted up, and the corresponding signal flag is set to "1".

manner.

Step 1: A probability Pi of the status change in the updating time interval ΔT is determined based on a total time T_o of the status monitoring and a frequency α_i of the input buffer.

$$Pi = \frac{\alpha_i}{T_o} \Delta T$$

Step 2: Sort the objects of the management table in the descending order of Pi. Thus, the content of the management table is changed.

Step 3: Optimize the grouping so that the value K_2 is minimized.

Step 4: Store the top item number and the bottom item number of each group into I_S and I_E after the optimization of the grouping.

The speed-up when the process is divided as the objects are grouped is now explained.

When the processing Fj can be divided to

$$Fj = fj_1 \oplus fj_2 \oplus \ldots\ldots \oplus fj_M$$

as the objects are grouped, only fi_I whose signal flag representing the status change in the group I is "1" need be updated. In the above formula, $\oplus$ indicates that the processing Fi can be divided.

Fig. 8 shows a format of the manag ment table

Step 3: If the element (I, j) is "0", it means that there is no process related to the group I in Fj. Go to a step 5. If the element (I, j) is "1", it means that the processing of fj^I is required. Go to a step 4.

Step 4: Process fj^I, store the result in the element (I, j) and set the decision making support information updating flag by setting the element (M+1, j) to "1".

Step 5: Set j to j+1. If j > n, go to a step 6. If $j \leq n$, go to a step 3.

Step 6: Set I to I+1. If I > M, go to a step 7. If $I \leq M$, go to a step 2.

Step 7: For all Fj whose elements (M+1, j) are "1", process Fj such that

$$Fj = fj^1 \oplus fj^2 \oplus fj^3 \oplus fj^4 \oplus \ldots\ldots \oplus fj^M$$

The expansion to the case where the time serial data processing is required is now explained.

In the support system for the decision making based on the situation like the trading support system aimed by the present invention, the time serial data is frequently handled. The time serial data processing G_K includes a portion which requires current real time information and a portion which uses only past time serial data. When the time serial data processing can be divid d into

the past time serial data is provided, and

(ii) The content of the element (I, j) is changed from fj^I to the processing $(fi^I)^R$ which depends only on the real time information.

The processing when the management table of Fig. 10 is used is substantially identical to the flow shown in Fig. 9. The differences are:

(i) The calculation step for fj^I in Fig. 9 is changed to the calculation step for $(Fj^I)^R$ based on only the real time information.

(ii) The calculation step for

$$Fj = fj^1 \oplus fj^2 + \ldots\ldots \oplus fj^M$$

in Fig. 9 is changed to the calculation step for

$$Fj = (Fj)^P \oplus (fj^1)^R \oplus (fj^2)^R \oplus \ldots\ldots \oplus (fj^M)^R$$

by using $(Fj)^P$ calculated based on the past data stored in the table.

An embodiment of the present invention which calculates a correlation coefficient to a market variation of the retained portfolio on the real time basis is now explained. A market variable is usually represented by a stock price index and it is informed as one of marked quotation information. It is stored in the data base 9 of Fig. 1 as th time serial data (daily closing price). The time serial data string is given by

$$\gamma j = \frac{x_o y_o + \sum_{i=1}^{N} x_i \cdot y_i}{\sqrt{x_o + \sum_{i=1}^{N} x_i^2} \sqrt{y_o + \sum_{i=1}^{N} y_i^2}}$$

The portions which depend on the past data are represented by

$$A^1 = \sum_{i=1}^{N} x_i y_i$$

$$A^2 = \sum_{i=1}^{N} x_i^2$$

$$A^3 = \sum_{i=1}^{N} y_i^2$$

Since y_o is calculated based on the current price Pi of the object in the following manner

$$y_o = \sum_i \omega ij \; Pi$$

the management table shown in Fig. 11 which is a merged one of Figs. 4 and 10 is utilized. Namely, a table which contains y_o (portfolio current total amount), Ai^3, $x_o y_o$, Ai^1, x and Ai^2 is added to the management table of Fig. 4. The processing which uses the table of Fig. 11 is explained below.

applicable to any real time status monitoring system and method.

In accordance with the present invention, the processing is done only for those objects whose data have been changed as opposed to the checking of all status at a constant time interval as is done in the multi-target tracking. Accordingly, not only the data amount to be processed is reduced but also the overall status of the object under the varying status can be easily grasped because it is easy to determine which decision making support information has been changed.

The present invention is effective to the system which monitors on the real time basis the function values which vary with the status of randomly changing data of different kinds.

quotation information in financial and security fields.

3. A real time status monitoring method according to Claim 1 wher in said plurality of data are measurement data from a number of sensors.

4. A real time status monitoring method according to Claim 1 wherein said plurality of data are aviation control data.

5. A real time status monitoring method according to Claim 1 wherein said plurality of data are traffic control data.

6. A real time status monitoring method comprising:

a first step of inputting a plurality of randomly varying data relating to a plurality of types of objects,

a second step of grouping the data;

a third step of preparing and grouping real time status management tables indicating which ones of the data a plurality of functions use as variables;

a fourth step of generating group data change flags indicating which group data of said data have been changed;

a fifth step of determining variables which are subjects of processing due to data change and types of functions which include such variables based on a function processing and flag indicating on which ones of the data the processing of the functions has been completed, and the group data chang flag;

a sixth step of processing only those functions

a sixth step of determining sub-function which ar subjects of processing and types of functions which include such sub-functions based on a decision making support information change flag indicating on which ones of the sub-functions the processing of the function has been completed and the signal flag;

a seventh step of processing only those functions which include the sub-functions which are subjects of processing due to the data change, in accordance with the determination result;

an eighth step of generating the decision making support information change flag indicating on which ones of the sub-functions the processing of functions has been completed, based on the processing of the functions in the seventh step; and

a ninth step of displaying the processing result of the functions.

9. A real time status monitoring method comprising:

a first step of inputting a plurality of randomly varying time serial data relating to a plurality of types of objects;

a second step of dividing the time serial data into a first data component relating to current real tim data and a second data component relating only to past time serial data;

a third step of preparing a management table indicating which one of the first data component and the second data component a plurality of functions use as

accordance with the real time status management table.

11. A real time status monitoring system comprising:

a central processing unit;

input means for inputting to said central processing unit a plurality of randomly varying data relating to a plurality of types of objects;

an input buffer for temporarily storing the input data supplied to said central processing unit;

status management table preparation means for preparing, under control of said central processing unit, a real time status management table indicating which ones of the data a plurality of functions use as variables for processing;

a data base for storing a method for preparing the status management table and the functions;

a vector processor for processing the functions in accordance with the status management table; and

a terminal device for displaying the processing result.

12. A real time status monitoring system according to Claim 10 further comprising a measurement register for measuring a frequency of updating of the data for a purpose of grouping.

13. A real time status monitoring system substantially as herein described with reference to and as illustrated in the accompanying drawings.

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